

The Origins of Socioeconomic Inequality in Cancer Mortality - Evidence from Denmark

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Motivation Life expectancy is strongly associated with socioeconomic status (Chetty et al., 2016; Kreiner et al., 2018; Kinge et al., 2019). Even in Denmark and other Nordic countries, men at the top of the income distribution can expect to live around 15 years longer than those at the bottom (Kreiner et al., 2018; Kinge et al., 2019). Surprisingly, the socioeconomic gradient in life expectancy in the Scandinavian countries matches that of the US (Chetty et al., 2016). This similarity, despite large differences in the design of the health care system between the US and the Nordic countries suggests a limited role for the health care system in explaining the observed differences in life expectancy. In contrast to this conjecture, a number of micro-level studies across countries find socioeconomic differences in the detection and treatment of diseases (Obermeyer et al., 2019; Yasaitis et al., 2014; Song et al., 2010; Van Ryn, 2002), with implications for mortality (Berglund et al., 2010; Forrest et al., 2013; Fiva et al., 2014)). In our proposed project, we aim to take a step towards understanding how these seemingly contradictory findings can be reconciled.

Research Questions and Empirical Analysis Our proposed research agenda consists of two parts. **Part I** takes a big picture approach and investigates the role of the health care system versus disease incidence in driving socioeconomic inequality in mortality and life expectancy. We focus on one specific setting, namely cancer-specific mortality in Denmark and ask the following question: **At what step(s) in the health care process does socioeconomic inequality in cancer-specific mortality originate and how quantitatively important is each step in causing this inequality?**

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To answer this question, we rely on register data covering the full Danish population and the entire health care process. We decompose socioeconomic inequality in cancer-related mortality into inequality that occurs at the following steps of the health care process: (1) tests for cancer, (2) the rate of positive tests, (3) the stage of cancer at diagnosis, (4) the choice of treatment and (5) mortality given treatment. Each of these steps is conditional on all previous steps, i.e. we follow the patient through the entire process and observe at what step the patient's socioeconomic status makes a difference for her transition to the next step.³ The contribution of each step to the overall inequality in mortality will be a function of the magnitude of the socioeconomic difference at this step and the importance of that specific step for mortality. Finally, we aggregate effects on mortality at each age to effects on life expectancy, thus obtaining an intuitive summary measure of the importance of each step, which directly relates to the literature on inequality in life expectancy. In sum, part I of our project sheds light on the extent to which cancer-related socioeconomic inequality in life expectancy is a result of the health care process (as compared to socioeconomic differences in cancer incidence) and if so, at what steps in the process this inequality originates.

Decisions at most steps in the health care process are a result of the interaction between the patient ("demand side") and the medical practitioner ("supply side"). Whereas Part I, our decomposition study, does not inform us about the role of the patient as compared to the doctor at each step in the health care process, **Part II** of our project aims to open the black box at one step, namely the testing for cancer. Taking breast cancer as our exemplary setting, we ask the following question: **How does a patient's belief about her risk of developing breast cancer affect her demand for medical testing?**

We answer this question by means of an online survey experiment targeted at women aged 35 to 65 who have not had breast cancer before. In the experiment, we first elicit each respondent's prior belief about her lifetime risk of breast cancer. Next, we feed information on demographics and family history into a well-established algorithm that provides an estimate of each woman's lifetime risk for invasive breast cancer (Gail et al., 1989). During a subsequent "information treatment", we

³Note that in the (theoretical) case in which socioeconomic (SE) inequality in cancer-related mortality is fully accounted for by a SE difference in the propensity to get tested for cancer, while there is no SE difference in rates of positive tests among those tested, this would be interpreted as evidence of a SE difference in the incidence of cancer, which is perfectly "captured" by the health care system.

provide a randomly selected half of the respondents, the “treatment group”, with the personalized prediction of the algorithm.⁴ The remaining respondents form the “control group” and do not receive any new information. By randomly disclosing the objective information to only one half of the respondents, we generate exogenous variation in beliefs about the individual lifetime risk of breast cancer.

Finally, we elicit our main outcome of interest: Subjects’ demand for a medical test that reveals whether the woman has a genetic disposition for breast cancer. To assess the true demand for this information, while ensuring the anonymity of all respondents, we inform each survey respondent that she is enrolled in a lottery. Before learning whether she won or not she has to decide whether she prefers a voucher for a genetic test or a monetary bonus as her prize.⁵ Based on the experimentally induced variation in beliefs about individual breast cancer risk, we can establish a causal effect of these beliefs on the demand for medical testing. In sum, part II of our project will provide insight into whether socioeconomic differences in the take-up of preventive screenings are the result of differences in patients’ beliefs about their cancer risk or of other factors, such as preferences.

Policy Relevance Inequality in health is high on the agenda both politically and in the public. The above-mentioned study of Chetty et al. (2016) on inequality in life expectancy in the US received no less than four New York Times articles, including a front-page article.⁶ In Denmark, the Danish national broadcasting station DR recently ran a highly debated series of programs under the heading ‘a sick difference’ (‘En syg forskel’) about inequalities in the Danish health care system.⁷

With our study, we hope to provide the knowledge needed for policy makers to assess whether the Danish health care system is contributing to health inequality and, if so, which type of policy would most effectively mitigate inequality. If our results from part I, the decomposition study,

⁴Note that we warn respondents upfront that they are about to receive a prediction of their breast cancer risk. They can opt out of the survey at any time by closing their browser. Their full anonymity is ensured, i.e. only the survey company we cooperate with knows their identity. Ethics approval for the experiment has been obtained.

⁵We are also going to elicit respondents’ willingness to pay for a number of other types of information about breast cancer that may be seen as both useful and unpleasant to varying degrees.

⁶See <https://www.nytimes.com/interactive/2016/04/11/upshot/for-the-poor-geography-is-life-and-death.html>

⁷See <https://www.dr.dk/nyheder/tema/en-syg-forskel>.

indicate that cancer-related inequality in life expectancy is largely due to differences in cancer incidence e.g. because of smoking or obesity, changing inequality in life expectancy requires policies aimed at changing the health behaviors of the poor. In contrast, if the health care process itself is producing inequality in life expectancy, our results will indicate which steps in the process to focus on if the aim is to reduce inequality. Part II of our project will provide complementary evidence by indicating whether biased beliefs of patients about their health risks are a source of socioeconomic inequality in decisions to get tested. If this is the case, an effective way to mitigate this inequality is to inform patients, for instance through information campaigns or via general practitioners.

Contribution to the Academic Literature Compared to the existing literature, the main advantage of part I, our decomposition analysis, lies in the fact that the Danish register data spans the entire health care process for the full population while at the same time allowing us to observe the patients' income. While existing studies usually focus on a specific step in the health care process⁸, we are able to speak to the big-picture question on the relative importance of the incidence of (different types of) cancer and of the different steps in the health care process.

Similarly, our experimental study on patients' beliefs about their breast cancer risk is highly topical. Even though personalized information about individual health prospects becomes more and more accessible and precise based on "big data" analysis and genetic tests, we have very little knowledge about how individuals learn about their health over time. Existing studies focus on the correlation between patients' beliefs about their health risks and demand for precise knowledge about their health, but come to different conclusions, depending on the context (Lange, 2011; Oster et al., 2013). Our study is, to the best of our knowledge, the first to provide clean causal evidence on how people's demand for medical testing (or for other ways of reducing uncertainty about health risks) depends on their initially perceived risk.

⁸One notable exception is Taksler et al. (2012) who decompose racial differences in prostate cancer into different pre- and post-diagnosis factors. Whereas Taksler et al. (2012) only observe Medicare patients in the US, we observe the full population of Denmark. For typical studies focusing on individual steps in the health care process see e.g. Lundqvist et al. (2016); Bach et al. (2002); Sjøgaard et al. (2013); Sidorchuk et al. (2009); Forrest et al. (2013, 2017)

Timeline and Expected Output The output of the project is expected to be 1-2 academic papers. With the first part of the study, the decomposition analysis, we aim for a general interest or medical journal such as PNAS or JAMA. The experimental second part of the study may be included in the same paper or may alternatively lead to a publication in a top field journal in economics. In addition, we expect to present the results to Danish policy makers in a variety of ways. Specifically, we are going to document our main results from part I of our project in compelling and easy-to-interpret charts, in which we decompose the overall cancer-specific inequality in life expectancy into differences that originate at the various steps in the health care process. The following table outlines our planned timeline.

Table 1: Timeline

| Date | To Do |
|------------------------------|--|
| Part I | |
| November 2019-May 2020 | Data Analysis |
| May - June 2020 | Write up working paper |
| July 2020-March 2021 | Presentation at workshops and conferences |
| April 2021 | First submission to academic journal |
| Part II | |
| November 2019 - January 2020 | Pilot studies with small samples (costs are covered) |
| February-March 2020 | Prepare and test final survey |
| April 2020 | Data collection and analysis |
| May - June 2020 | Write up working paper |
| July 2020-March 2021 | Presentation at workshops and conferences |
| April 2021 | First submission to academic journal |

Both applicants have proven experience with the planned empirical approaches: Benjamin Ly Serena has recently published a paper on inequality in life expectancy in Denmark (Kreiner et al., 2018), has 7 years of experience working with the Danish register data and is currently working on several projects using decomposition methods. Sonja Settele has conducted survey experiments in several studies in the past (Settele, 2019; Roth et al., 2019), one of which was invited for resubmission at the highly ranked Journal of Econometrics.

Budget This application concerns funds for an online survey as well as a teaching buy-out of two months per researchers, i.e. four months in total. We would like to apply for financial support

amounting to **DKK 360.232**. The following Table outlines the planned use of funds in detail.

Table 2: Budget overview

| Item Description | Number of items and costs per item | Amount in DKK |
|----------------------------|------------------------------------|-------------------|
| Survey responses | 3500 respondents à DKK22,5 | 78,750 |
| Lottery | One lottery winner à DKK3750 | 3,750 |
| Other incentivized choices | 700 choices à DKK50 | 35,000 |
| SubTotal Experiment | | 117,500 |
| Teaching buy-out | 4 months à DKK45,673.50 | 182,694 |
| Overhead | 20% of other costs | 60,038.80 |
| Total | | 360,232.80 |

Notes: For the survey experiment, we are going to use an online sample provided by a survey company. Costs for survey responses are based on a preliminary offer by a survey company. The exact costs for the lottery and the other incentivized choices depend on the choices made by the respondents during the experiment.

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